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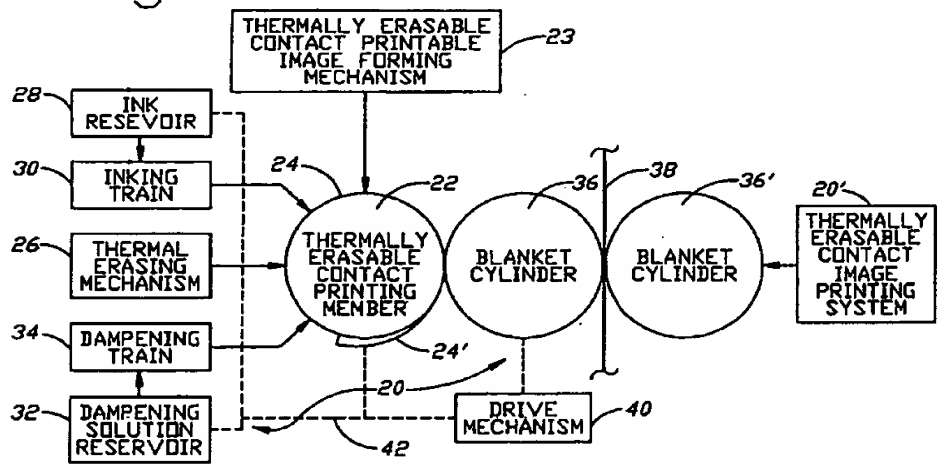
(54) Erasable contact printing assembly, printing apparatus and printing method and method of making the same

(57) A printing assembly (20) with a thermally erasable printing member (22) having a surface (24) for supporting an erasable contact printable image (87) for contact printable image (87) for contact printing copies of the image a blanket cylinder (36) engageable with the erasable printing member (22) and a drive mechanism (40) for moving the erasable printing member (22) into contact printing engagement with a web medium (38) onto which the image is to be printed and a thermal erasing mechanism (26) mounted in a relatively fixed relationship with respect to the drives mechanism (40) for thermally erasing the contact printable image to enable a new contact printable image to be carried by the erasable printing member (22) for contact printing of the new contact printable image.

Fig.1



EP 0 724 967 A1

Description

BACKGROUND OF THE INVENTION

Field of the Invention:

This invention relates generally to contact printing and more specifically to apparatus and methods relating to erasable contact printing.

Description of the related art including information disclosed under 37 CFR 1.97 - 1.99:

In modern day contact printers, such as high speed continuous web rotary printers used to print newspapers, magazines and the like, metallic printing plates which carry the contact printable images etched upon their surface are mounted to a rotary plate cylinder. Parts of the image surface are hydrophobic and oleophilic, or inkophilic. An inking train and wetting solution train of rollers continuously delivers a layer of both ink and wetting solution to the surface of the printing plate carried by the plate cylinder. Ink is held to the inkophilic surfaces forming the image to be printed and is transferred to a blanket cylinder and from the blanket cylinder the image is transferred to the paper web. The plates are releasably mounted by various means to the cylindrical outer surface of the plate cylinder.

While it is known in xerography to also provide a printing drum on which images are made that can be repeatedly erased and reused to form new images, such a desirable feature has not yet been obtained in the area of contact printing. Thus, disadvantageously, in contact printing presses, if it is desired to change the image being contact printed, it is necessary to stop the operation of the press while the plate bearing an undesired image is removed from the plate cylinder and an interchangeable plate bearing the desired image is mounted in its place. The press is then restarted and operated until it is again time to substitute plates. The steps of mounting, dismounting and interchanging plates are repeated continually.

The images on the plates are formed off the press and must be delivered to the press, and the used plates need to be collected and moved away from the press to a remote recycling location. At the recycling location, the impurities are removed, and the plates are melted down and reused. In addition to the disadvantages, the mounting of the plates to the plate cylinder results in the creation of gaps at the edges of the plate and inertial anomalies which create plate cylinder and roller vibrations that can detract from the quality of the printing.

More recently, apparatus and methods have been proposed for erasing contact printable images on image printing cylinders and forming new contact printable images on the erased image printing cylinders while remaining mounted to the press, thus eliminating the need for interchanging plate cylinders. The surfaces of image printing cylinders are coated with an oxide semiconductor into which an image is formed by laser generated cathodic photodetector deposition and the image is removed by chemical or electrochemical dissolution in the press shown in U.S. Patent 5,706,102 issued April 27, 1993 to **Tench**. Likewise, a method of magnetically removing a magnetically formed image from the surface of the plate through use of a scraper and countermagnet is shown in U.S. Patent 5,188,033 issued February 23, 1993 to **Fadner**. The recycled or virgin plates then again must be delivered to the plate imaging location for image formation and then delivered to the press. While these so called direct-to-press imaging systems and methods function satisfactorily, they also present certain disadvantageous characteristics. Such known direct-to-press systems further require significant initial set-up, image removal and delivery times. Moreover, abnormalities in the printing product periodically occur in known direct-to-press imaging systems.

SUMMARY OF THE INVENTION

It is therefore the principal object of the present invention to overcome the problems noted associated with the use of interchangeable plates in contact printers eliminating the need for changing plates to change the contact printable images carried by the plates as well as the problem of the known direct-to-press imaging and image removing systems.

This objective is achieved in part by provision of a printing assembly, comprising an erasable printing member with means for supporting an erasable contact printable image for contact printing copies of the image, means engageable with the erasable printing member for relatively moving the erasable printing member into contact printing engagement with a medium onto which the image is to be printed and means mounted in relatively fixed relationship with respect to the moving means for thermally erasing the contact printable image to enable a new contact printable image to be carried by the erasable printing member for contact printing of the new contact printable image. Preferably, the printing assembly includes means for applying the new contact printable image to the printing member while the erasable printing member is engaged with the relatively moving means.

Preferably, the printing assembly includes at least one of means for (a) combustion heating, (b) microwave heating, (c) laser heating, (d) UV radiation heating, (e) infrared radiation heating and (f) other radiant heating. The printing member includes an image support surface for supporting an image forming substance in which the contact printable image is formed. The image support surface is preferably made of a material that is structurally sound at temperatures higher than at least one of (a) the decomposition temperature and (b) the vaporization temperature range, of the image forming substance. Preferably, the image forming substance is a photopolymer imaging substance and the image support surface is made of at least one of (a) ceramic, (b) a

composite of metal and ceramic, (c) a metal, (d) a metal alloy and (e) other material with at least one of (1) a melting temperature range, (2) a vaporization temperature range, and (3) decomposition temperature range greater than that of a substance from which the contact printable image is formed.

The principal object of the invention is also partly achieved by providing a reusable printing apparatus, comprising a body for carrying an erasable image support surface adapted for support of a coating of contact printing image forming substance having preselected thermal characteristics and material at the erasable image support surface with thermal characteristics relative to the preselected thermal characteristics of the contact printing image forming substance sufficient to maintain structural integrity of the image support surface during application of sufficient heat energy to remove enough of the image forming substance from the erasable image support surface to enable support by the erasable image support surface of a new coating of contact image printing forming substance for formation of a new image.

Preferably, the material at the image support surface of the reusable printing apparatus is made at least partly of one of (a) ceramic, (b) a composite of metal and ceramic and (c) other material with at least one of (1) a melting temperature range, (2) a vaporization temperature range and (3) decomposition temperature range greater than that of the contact printing image forming substance. The image support surface is preferably adapted to have a roughness on the order of fifty micro-inch Ra. The image support surface material is hydrophilic and the image forming substance is a hydrophobic coating of one of (a) a photosensitive material for forming an image by means of a photoprocess, (b) an erodible material formable into an image by means of an ablative process and (c) a photopolymer substance. The material at the image support surface has a melting temperature range that is higher than at least one of (a) the decomposition temperature range and (b) the vaporization temperature range of the image forming substance.

Preferably, the body of the reusable printing apparatus includes a substrate made of matter different than the material at the image support surface to support the material at the image support surface and having a thermal conductivity less than that of the material at the image support surface. The substrate is made of one of (a) aluminum oxide and (b) chromium oxide.

Also, in the preferred embodiment, the reusable printing apparatus includes an image forming substance heat facilitating catalyst mixed in with the material at the erasable image support surface. The catalyst preferably includes at least one of the metals Pt, Pd, Ir and Ni and the like or oxides of Ce or Ru and the like for enhancing at least one of (a) oxidation and (b) volatilization of organic compounds.

The object of the invention is further achieved by providing a method of contact printing with a printing press, comprising the steps of (1) forming a contact printable image on a printing member, (2) using the printing member to contact print a copy of the printable image and (3) thermally erasing the contact printable image from the printing member while the printing member remains attached to the printing press to enable formation of a new contact printable image on the printing member.

Preferably, the step of forming a contact printable image on the printing member is performed while the printing member is attached to the printing press by means of a photographic imaging process.

In the preferred embodiment of the printing press of the present invention, the step of forming the contact printable image includes the steps of (1) preforming an erasable image support surface on the printing member, (2) applying a photoimagable substance as a thin film to the image support and (3) selectively removing parts of the photoimagable substance from the image support surface to form the image. The method step of preforming an image support surface preferably includes the steps of (1) preforming a hydrophilic support surface on the printing member and (2) applying the photoimaging material as a thin film of hydrophobic photoimaging material to the image support surface. The step of coating the printing member with a material preferably includes at least one of (a) a ceramic material (b) a composite of ceramic and metal (c) a metal (d) a metal allay and (e) other material with at least one of (1) a melting temperature range, (2) vaporization temperature range and (3) decomposition temperature range greater than that of the photoimagable substance. The photoimagable substance of the contact printing method has (a) an oxidation onset temperature point (b) a decomposition onset temperature point and (c) a volatilization temperature point, and removal is performed by raising the temperature of the photoimagable substance at least above one of these temperature points (a), (b) and (c).

The objective of the invention is also obtained in part by providing a method of making a reusable contact printing apparatus, comprising the steps of (1) forming a support body with a substrate surface adapted to support a reusable image support material and (2) securing erasable image support material to the substrate surface to provide an image support surface for successive support of new coatings of image forming substance with preselected thermal characteristics and in which contact printing images are formable, said erasable image support material having thermal characteristics relative to the preselected thermal characteristics of the image forming substance to maintain structural integrity of the erasable image support material during application of sufficient heat energy to remove enough of the image forming substance from the image support surface to enable support of a new coating of image forming substance for formation of a new image.

Preferably, the step of securing the erasable image support material to the substrate surface is performed by at least one of the steps of (a) spraying a coating of

image support material onto the substrate surface, (b) thermal spraying the erasable image support material at temperatures near the melting point temperature of the image support material, (c) spraying the erasable image support material onto the substrate surface at speeds on the order of the speed of sound and (d) spraying the image support material onto the substrate together with a high velocity oxygen fuel. Roughening the substrate surface enhances adhesion of the image support material to the substrate surface. The step of securing erasable image support material is performed by coating the substrate surface with the erasable image support material to a thickness on the order of 0.1 mils.

Preferably, the erasable image support material is at least one of (a) ceramic (b) composite of ceramic and metal (c) metal (d) a metal alloy and (e) other material with at least one of (1) a melting temperature range, (2) vaporization temperature range and (3) decomposition temperature range greater than that of a substance from which the contact printable image is formed. The step of forming the body is performed by forming the body with a substrate surface made of material different than the erasable image support material, and the body is preferably made of a material having a thermal conductivity less than that of the image support material.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing objects and advantageous features of the invention will be explained in greater detail and others will be made apparent from the detailed description of the preferred embodiment of the present invention which is given with reference to the several figures of the drawing, in which:

Fig. 1 is a partially schematic partially functional block diagram of a preferred embodiment of a printing assembly of the present invention;

Fig. 2A is a more detailed functional block diagram of a preferred form of the image erasure block of Fig. 1;

Fig. 2B is a more detailed functional block diagram of another form of the image erasure blob of Fig. 1;

Fig. 3A is a more detailed functional block diagram of the image forming mechanism block of Fig. 1;

Fig. 3B is a more detailed functional block diagram of another form of the image forming mechanism block of Fig. 1;

Fig. 4A is an enlarged cross sectional view of the surface of the erasable contact printing member of Fig. 1 as it appears before receipt of a coating of image forming substance and after it has been erased;

Fig. 4B is an enlarged cross sectional view of the surface of the thermally erasable contact printing member of Fig. 1 as it appears after the image forming substance coating has been applied and before the image has been formed;

Fig. 4C is an enlarged cross sectional view of the surface of the thermally erasable contact printing member of Fig. 1 as it appears after the contact printable image has been formed;

Fig. 5 is an enlarged portion V of Fig. 4C illustrating the macro and micro structures of the image support surface of the erasable printing member;

Fig. 6 is a flow chart of the preferred method of contact printing in accordance with the present invention; and

Fig. 7 is a flow chart of the preferred method of making a reusable contact printing apparatus of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to Fig. 1, the preferred embodiment of the thermally erasable contact printing assembly 20, is seen to include three unique elements: a thermally erasable contact printing apparatus, or printing member 22; a thermally erasable contact printable image forming mechanism, or image forming mechanism, 23 and a thermal erasing mechanism 26.

In addition to these novel elements 22, 23 and 26, conventional elements are also provided. Ink contained in an ink reservoir 28 is conveyed via an inking train 30 to the surface 24 of the thermally erasable contact printing member 22. Likewise, dampening solution in a dampening solution reservoir 32 is conveyed via a dampening train 34 of rollers to the surface 24 of the thermally erasable contact printing member 22. A thermally erasable contact printable image is formed on the surface 24 by means of which the ink delivered to the surface 24 is selectively held to portions of the surface 24 to form the desired image. The ink forming the image is then transferred to a blanket cylinder 36. The blanket cylinder 36 in turn, transfers the ink in the form of the image to one side of a web 38 paper.

On the opposite side of web 38, in the case of a duplex or double-sided printer, is another blanket cylinder 36' onto the surface of which is printed another image by means of a thermally erasable contact image printing system 20' containing all the components of the thermally erasable contact printing assembly 22-32, except blanket cylinder 36', which are used to print images on the opposite side of web 38. The details of the ink reservoir 28, the inking train 30, the dampening solution reservoir 32, the dampening train 34 and the blanket cylinder 36 form no part of the present invention, and as such details are required, reference should be made to the aforementioned United States Patents Nos. 5,188,033 to **Fadner** and 5,206,102 to **Tench** and the references cited therein.

While the advantageous features of the invention are employed to their optimum extent when used with a high volume, high speed, continuous web rotary press, such as used to print newspaper and the like, the invention is capable of being employed in connection with

other types of printing presses. For instances, in the absence of a use of the invention in a duplex press, the blanket cylinder 36' is exchanged for an idler roller and the blanket cylinder thermally erasable image printing system 20' is eliminated. Further, it should be appreciated that the features of the invention can also be successfully employed in a nonrotary press as well as a noncontinuous web press.

In the preferred embodiment, the thermally erasable contact printing member 22 is in the form of a printing cylinder as schematically illustrated in Fig. 1. and shown in some greater detail and described with reference to Figs. 4A, 4B and 4C, which replaces a conventional plate cylinder adapted to carry removable printing plates as discussed above.

While the need for removable printing plates is preferably eliminated, it is also contemplated that the process for forming a thermally erasable image in accordance with the present invention can be use in association with removable printing plates, such as a removable printing plate 24' schematically illustrated in Fig. 1, to some advantage. In such a case, the printing plates are removed from the press and new plates substituted when it is desire to print new images. The new plates have the images formed in advance, and the old plates which are removed are erased while printing commences immediately with the new plates. The erased plates are then recycled by applying new images for printing.

In either event, whether the thermally erasable printing member is a removable printing plate 24' or the surface 24 of a rotatably mounted, thermally erasable, contact printing cylinder, or other image support member, 22, the important aspect of the invention is that means are provided at the surface for supporting a thermally erasable contact printable image for contact printing multiple copies of the image. A drive mechanism 40, together with a frame 42 holding the various rollers of inking train 30, dampening train 34, thermally erasable contact printing member 22, blanket cylinder 36 and web 38 in relatively fixed cooperative rotary printing engagement provide the means for rotatably moving the thermally erasable contact printing member 22 and surface 24 into contact printing engagement with the blanket cylinder 36, the web 38 or any other medium onto which the image is to be printed or transferred directly. In the case of a thermally erasable contact printing member 22 which is mounted in relatively fixed relationship with respect frame 42 and is not removable, such as the thermally erasable contact printing plate 24' which is removable, the thermal erasing mechanism 26 is mounted in relatively fixed relationship with respect to the other elements of the thermally erasable contact printing assembly 20, including frame 42 and drive mechanism 40. Thus, in such case, the thermally erasing of contact printable image to enable a new contact printable image to be carried by the thermally erasable contact printing member 22 for contact printing of a new contact printable image is performed "on press". However, as noted above, in the case of removable thermally erasable contact printing plate 24', the thermal erasing mechanism 26 is enabled off press.

Likewise, the thermally erasable contact printable image forming mechanism 23 is also preferably mounted in a substantially fixed relationship relative to the thermally erasable contact printing member 22 and the other elements of the thermally erasable contact printing assembly 20. As will be explained in greater detail below with reference to Fig. 6, the thermally erasable contact printing image forming mechanism 23 forms a contact printable image on surface 24 of the thermally erasable contact printing member 22 when the press is stopped. The operation of the press is then recommenced and runs until the desired number of copies of the image have been printed. Then the press is stopped again and the contact printable image on the surface 24 is thermally erased by the thermal erasing mechanism 26. After erasure is completed, a new image is formed on the surface 24 of the thermally erasable contact printing member 22 by the thermally erasable contact printable image forming mechanism 23, and the cycle is repeated.

Referring now to Fig. 2A, in the preferred embodiment the thermal erasing mechanism 26 applies heat 43 to the contact printable image carried on the surface 24 of the thermally erasable contact printing member 22 by the direct application of flames from a flame output manifold 44. The flame output manifold 44 directs combusting gaseous fuel directly onto the surface 24 to produce heat in sufficient quality at the surface 24 to remove the contact printable image from the printing member 22. The output manifold 44 is fed with combusting fuel from a combustion chamber 46. Combustible fuel, such as hydrogen, methane, ethane, butane, propane, acetylene or combinations thereof from fuel supply 48 is fed through a regulator 50 and a fuel inlet valve 52. The fuel inlet valve 52 and the ignitor 54 are controlled by an image erasing controller 56. A safety exhaust valve 58 is provided to limit the maximum pressure within combustion chamber 46. A thermometer 60 is used to sense whether combustion has occurred within combustion chamber 46, and if combustion does not occur within a preselected time following attempt to ignition by ignitor 54, the image erasing controller 56 closes fuel inlet valve 52 and opens safety exhaust valve 58. During the erasing process, the image erasing controller 56 causes the drive mechanism 40, to rotate the thermally erasable contact printing member 22 gradually past the flame outlets of the flame outlet manifold 44 until the entire image has been traversed and erased..

Referring now to Fig. 2B, an alternate form of the thermal erasing mechanism 26, designated 26' is seen to have eliminated the safety exhaust valve 58, the combustion chamber 46, the fuel inlet valve 52, the regulator 50, the fuel supply 48, the thermometer 60, and the ignitor 54 with a single radiation heating source 62 provided with electrical power by a suitable power supply 64. The image erasing controller 56, still controls the drive

mechanism 40 to cause the thermally erasable contact printing member 22 to scan the image past a region of radiation which is generated by the radiation heating source 62 and impinges upon a section of the thermally erasable contact printing member 22. Preferably, the radiation heating source 62 supplying radiant heat 66 to the thermally erasable contact printing member 22 comprises a sufficiently powerful source of one of (a) microwave heating, (b) laser heating, (c) UV radiation heating, (d) infrared radiation heating and (e) other radiate heating. The important aspect is that the degree of heating is sufficient to erase the image on the surface 24 of the thermally erasable contact printing member 22. The image support surface 24 of the thermally erasable contact printing member 22 supports an image forming substance in which the contact printable images are formed by the thermally erasable contact printable image forming mechanism 24. In accordance with the present invention, this image support surface 24 is made of a material that is structurally sound at temperatures higher than at least one of (a) decomposition temperature and (b) the vaporization temperature range of the image forming substance. Thus, as a minimum, the radiation heating source 62 or the combustion flames 43 of Fig. 2A, must heat the surface to at least one of these temperatures. In addition, in the case of an imaging substance having no impurities and subjectable to use in the vicinity of known environmental pollutants, each with a decomposition and vaporization temperature range, the material of the image support surface 24 is selected to have a decomposition and vaporization temperature range respectively in excess of the impurities and the known environmental pollutants. In such case, the radiation heating source 62 or the combustion flames 43 of Fig. 2A, must sufficiently raise the temperature above one of the decomposition and vaporization temperature ranges of these impurities and environmental pollutants to insure that the thermally erasable contact printing member 22 is completely erased.

In the preferred embodiment, the image forming substance 86 (Fig. 4B) is a photopolymer composition such as the photopolymerizable composition described in U.S. Patent 5,254,429 issued October 19, 1993 to **Gracia et al.**, a diazo-based coating such Standard Negative™ (supplied by Western Lithotech), the radiation polymerizable composition described in U.S. Patent 5,120,772 issued June 9, 1992 to **Walls et al.**, the photopolymerizable composition containing poly-butanediol-diacrylate with a photo initiator and binder described in U.S. Patent 4,952,482 issued August 28, 1990 to **Barton et al.**, the radiation polymerizable composition containing polyfunctional monofunctional acrylic monomers described in U.S. Patent 4,946,373 issued August 7, 1990 to **Walls et al.**, the composition described in U.S. Patent 4,851,319 issued July 25, 1989 to **Walls et al.**, the photopolymerizable composition containing cationically curable epoxides as described in Great Britain Patent 2,137,626 published October 10, 1984 to **Dickinson et al.** or the like that exists in a liquid state or can be dissolved or suspended in a liquid vehicle for application by roller coating or spray coating of the image support surface 24. The excess solution or suspension of the image-forming substance is collected and may be recycled. The liquid portion of the solution or suspension of the photopolymerizable composition evaporates leaving a photopolymerizable layer of the image-forming substance 86 on the image support surface 24.

Referring to Fig. 3A, the thermally erasable contact printable image forming mechanism 23 is said to include a photosensitive image forming substance spray-coater or roller-coater 6668 for applying a thin coat of photosensitive, image-forming substance or solution or suspension thereof from a photosensitive image forming reservoir 70 onto the surface 24 of the thermally erasable contact printing member 22. The photosensitive image forming substance is selectively recycled through employment of an appropriate photosensitive imaging substance recycling system 63. Imagewise irradiation of the image forming photopolymer coating by light of the appropriate wavelength can be provided by a computer-directed laser beam or other state-of-the-art imagers. The imagewise exposed imaging material 86 in Fig. 4B is then developed by treating with an appropriate developer 51 such as a dilute aqueous solution of sodium carbonate, described in European Patent No. 539,881 A1 of **Santos et al.** published June 5, 1993, for diazo based embodiments of the imaging substance, or the alkaline developer described in Great Britain Patent No. 2,226,150 published June 20, 1990 to **Tidningsplat.** The developer may be spray applied to the support surface 24 with the excess collected and recycled by an appropriate developer recycling system 67.

A photoimager 72, such as any suitable state of the art computer to plate imager, transposes selected images onto the coat of image forming substance. An image forming controller 74 controls the drive mechanism 40 to coordinate the rotary movement of the thermally erasable contact printing member 22 with the operation of the PIFS sprayer 68 and the photoimager 72.

Referring now to Fig. 3B, an alternative form of the thermally erasable contact printable image forming mechanism 23' is shown with an image forming substance (IFS) sprayer 78 or roll coater employed for providing a coating of image forming substance on the surface 24 of the thermally erasable contact printing member 22. The IFS sprayer 78 receives quantities of the image forming substance from the erasable image forming substance reservoir 80 and accordingly coats the surface 24 of the printing member 22. An ablative imaging system 76 such as one which employs a carbondioxide laser is used to transpose the selected image of the coat of the image formable substance. The ablative imaging system 76 separates the image formable substance coating into selected image and non-

image areas on the printing member 22 to produce the desired thermally erasable image on the surface 24.

Referring now to Fig. 4A, the thermally erasable contact printing member 22 is shown with an image support surface 82 applied to a substrate body 81 of the printing member prior to receipt of an image forming substance on the surface 24. The image support surface 82 is preferably made of a ceramic mixture, a composite of metal and ceramic, a metal, a metal alloy or other suitable material. One of these selected metal, ceramic or composite materials preferably has a melting temperature range or a vaporization temperature range or decomposition temperature range greater than that of the contact printable image substance 86, Fig. 4B. The cylindrically formed support body 81, Fig. 4A, carries the thermally erasable image support surface 82 having a material 84 which has melting temperature of not less than one thousand centigrade degrees and has a thermal conductivity range on the order of 10.0-240 watt/meter/degree Kelvin.

The substrate body 81 of the printing member 22 is made of a matter which differs from the ceramic or metallic compound material 84 of the image support surface 82. The substrate 81, which is preferably an aluminum oxide or chromium oxide compound, steel alloy or the like, supports the image support surface material 84 and has a thermal conductivity which is less than that of the material at the image support surface. Alternatively, the substrate surface 90 is a plate which is mountable to a plate cylinder of the printing press. A printing plate 24', as seen in Fig. 1, is placed on the surface 90 of the substrate body 81 in which the image support surface 82 is subsequently coated thereon. The ceramic or metallic compound material 84 at the image support surface 82 is coated on the substrate surface 90 to a thickness on the order of 0.1 mils. The substrate body 81 is selectively made of stainless steel or carbon steel.

Referring now to Fig. 4B, the thermally erasable contact printing member 22 is shown with an image forming substance 86 coating supported by the image support surface 82. A thin layer coating of the image forming substance 86 is sprayed on the image support surface 82 prior to the formation of the contact printable image. In the preferred embodiment, the image support surface 82 is made of a material that is structurally sound at temperatures higher than the decomposition temperature or alternatively, the vaporization temperature range of the image forming substance 86. The hydrophilic image support surface 82 comprising a ceramic, a metal and ceramic composite, a metal, a metal alloy or another material has melting temperature range and a vaporization temperature range which is greater than the hydrophobic contact printable image substance 86. Preferably, the image forming substance 86 is a photopolymer imaging substance such as described above. The melting temperature range of the material 84 at the image support surface, is approximately 500 centigrade degrees higher than the decomposition temperature range or vapor temperature range of the coated image forming substance 86.

Referring now to Fig. 4C, the printing member 22 is shown after the contact printable image 87 of the image forming substance 86 is formed by the ablative imaging system 76, Fig. 3B, or the photoimager 72, Fig. 3A, on the surface of the image support material 82. The coating of the hydrophobic image forming substance 86, as seen in Fig. 4B, is transformed into the contact printable image 87, Fig. 4C, by the photoimager 72 or the ablative imaging system 76 in the thermally erasable contact image forming mechanism 23. Ink adheres to the hydrophobic contact image forming substance to create and transfer the printable image. The coating of the image forming substance 86 in the preferred embodiment is selectively either a photosensitive material for forming an image by means of a photoprocess, or any other hydrophobic organic film which is formable into an image on the printing member surface 24 through an ablative process or a photopolymer substance.

The forming of the contact printable image 87 is accomplished by preforming a hydrophilic and erasable image support surface 82 on the body 81 of the printing member 22. A photoimagable substance 86 as the ones described above is applied as a thin film to the image support surface, as seen in Fig. 4B. Portions of the applied photoimagable substance thin film 86 are selectively removed from the support surface 82 by spraying on or immersing the support surface 82 coated with the thin film 86 in a suitable developer such as an alkaline developer to form the contact printable image 87. Preferably, the underlying support surface 82 is of a water-loving hydrophilic material and the applied photoimaging forming substance 86 is of a ink-loving and water-resistant hydrophobic material. Removal of the hydrophobic photoimagable forming substance 86 is performed by raising the temperature of the photoimagable substance, as described in Figs. 2A and 2B, above the oxidation onset temperature point, the decomposition onset temperature point or the volatization temperature point of such photoimagable substance. The ceramic, metal or ceramic and metal composite material 84 at the image support surface 82 has thermal characteristics relative to the thermal characteristics of the image substance 86 which are sufficient to maintain the structural integrity of the image support surface during the application of heat energy when removing the image forming substance from the erasable support surface to enable support of a new coating of contact image printing forming substance for formation of a new image.

Referring now to Fig. 5, the macro and micro structures of the image support surface 82 and the printing image forming substance 86 are shown on the thermally erasable printing member 22. To enhance the adhesion of the image forming substance 86 the image support surface 82 is roughened thereby enabling increased securement of the image forming substance. The image support surface 82 has a coarse and roughened shape to enhance adhesion to the image forming substance

86. Additionally, the image support surface 82 has a plurality of pores 92 which adhere to the image forming substance 86. Roughening of the image support surface 82 is selectively achieved by etching the ceramic or metallic surface, particle blasting the surface or the rough surface inherently characteristic of the particulate nature of the material. Roughening may alternatively be performed by chemical or electrochemical etching as described in European Patent Publication No. 471,351 A1 of **H. Sakaki** published February 19, 1992. Preferably, the image support surface 82 has a roughens factor of approximately fifty micro-inch Ra. The material 84 at the erasable image support surface 82 is mixed with an image forming substance heat facilitating catalyst. The heat facilitating catalyst is preferably a metal such as Pt, Pd, Ir, Ni or the like or oxides of Ce or Ru or the like which is employed for enhancing the oxidation and volatilization or organic compounds.

While the advantages of the present invention are preferably achieved in the printing assembly having blanket cylinders with a drive mechanism operating in conjunction with dampening and inking trains of rollers, as seen in Fig. 1, the preferred method of contact printing can be used in various types and sizes of printing presses by (1) forming a contact printable image on a printing member (2) using the printing member to contact print a copy of the printable image and (3) thermally erasing the contact printable image from the printing member while the printing member remains attached to the printing press to enable formation of a new contact printable image on the printing member. The new contact printable image is formed on the printing member 22 while the printing member remains attached to the printing press after the previous contact printable image is erased.

Referring now to Fig. 6, the preferred method of contact printing begins at step 100 in which the reusable and erasable image support surface 82 on the body of the thermally erasable printing member 22 is coated with the contact printing image forming substance 86. In step 102, the desired image is formed in the coating of the image formable substance 86 through an ablative or photoimaging process as described in Figs. 3A and 3B. The printing press 20 is started in step 104. In step 106, the desired number of copies of the image coated on the image support surface 82 by way of the image forming substance 86 is contact printed on the web 38 or other selected medium. In step 108 the printing press 20 is stopped. The contact printable image 87 is thermally erased by substantially removing all the contact image formable substance 86 from the image support surface 82. The process returns to step 100 in order to begin contact printing of a new contact printable image on to a selected printing medium.

The preferred method of making a reusable contact printing apparatus in the present invention is performed by (1) forming a support body with a substrate surface adapted to support a reusable image support material and (2) securing erasable image support material to the substrate surface to provide an image support surface for successive support of new coatings of image forming substance with preselected thermal characteristics in which contact printing images are formable with the erasable image support material having thermal characteristics relative to the preselected thermal characteristics of the image forming substance to maintain structural integrity of the erasable image support material during application of sufficient heat energy to remove enough of the image forming substance from the image support surface to enable support of a new coating of image forming substance for formation of a new image. The erasable image support material 84 is secured to the substrate body 81 by spraying a coating of image support material onto the substrate surface 90. The erasable image support material 82 is selectively secured to the substrate surface 90 by: thermally spraying the erasable image support material at temperatures near the melting point temperature of the image support material; by spraying the erasable image support material onto the substrate surface 90 at speeds on the order of the speed of the sound or by spraying the image support material 82 onto the substrate 81 together with a high velocity oxygen fuel. The substrate support 81 body is formed with a cylindrical surface 90 and the image support material 84 is secured in uniform conformity with the substrate surface to provide a cylindrical erasable image support surface.

Referring now to Fig. 7, the preferred steps of making a reusable contact printing apparatus are shown. In step 120, the cylindrical support body 81 is formed with a cylindrical surface 90. The erasable image support material 84 is secured in uniform conformity to the substrate surface 90 of the cylindrical support body 81 to provide a cylindrical thermally erasable image support surface 82 in step 122. In step 124, the image support material 84 is treated to form a roughened structure 92 at the substrate surface 90 for support of the image forming substance 86.

While a detailed description of the preferred embodiment of the invention has been given, it should be appreciated that many variations can be made thereto without departing from the scope of the invention as set forth in the appended claims.

Claims

1. A printing assembly, comprising:

an erasable printing member with means for supporting an erasable contact printable image for contact printing copies of the image;

means engageable with the erasable printing member for relatively moving the erasable printing member into contact printing engagement with a medium onto which the image is to be printed; and

means mounted in relatively fixed relationship with respect to the moving means for thermally erasing the contact printable image to enable a new

contact printable image to be carried by the erasable printing member for contact printing of the new contact printable image.

2. The printing assembly of claim 1 and the means for applying the new contact printable image to the printing member while the erasable printing member is engaged with the relatively moving means.

3. The printing assembly of claim 1 in which said thermal erasing means includes means for applying heat to the contact printable image in sufficient quantity to remove the contact printable image from the printing member.

4. The printing assembly of claim 3 in which said heating means includes at least one of means for (a) combustion heating, (b) microwave heating, (c) laser heating, (d) UV radiation heating, (e) infrared radiation heating and (f) other radiant heating.

5. The printing assembly of claim 1 in which the printing member includes an image support surface for supporting an image forming substance in which the contact printable image is formed, said image support surface being made of a material that is structurally sound at temperatures higher than at least one of (a) the decomposition temperature and (b) the vaporization temperature range, of the image forming substance.

6. The printing assembly of claim 5 in which the image forming substance is a photopolymer imaging substance.

7. The printing assembly of claim 1 in which the support means includes an image support surface that is made of at least one of (a) ceramic, (b) a composite of metal and ceramic, (c) a metal, (d) a metal alloy and (e) other material with at least one of (1) a melting temperature range (2) a vaporization temperature range and (3) decomposition temperature range greater than that of a substance from which the contact printable image is formed.

8. The printing assembly of claim 7 in which

the substance has known impurities with a melting temperature range, and is subjectable in use to known environmental pollutants with a melting temperature range, and

said other material has a melting temperature range in excess of that of the impurities and the known environmental pollutants.

9. A reusable printing apparatus, comprising:

a body for carrying an erasable image support surface adapted for support of a coating of contact printing image forming substance having preselected thermal characteristics; and

material at the erasable image support surface with thermal characteristics relative to the preselected thermal characteristics of the contact printing image forming substance sufficient to maintain structural integrity of the image support surface during application of sufficient heat energy to remove enough of the image forming substance from the erasable image support surface to enable support by the erasable image support surface of a new coating of contact image printing forming substance for formation of a new image.

10. The reusable printing apparatus of claim 9 in which the material at the image support surface is made at least partly of one of (a) ceramic, (b) a composite of metal and ceramic and (c) other material with at least one of (1) a melting temperature range (2) a vaporization temperature range and (3) decomposition temperature range greater than that of the contact printing image forming substance.

11. The reusable printing apparatus of claim 9 in which the image support surface is adapted to have a roughness on the order of fifty micro-inch Ra.

12. The reusable printing apparatus of claim 9 in which

the image support surface material is hydrophilic, and

the image forming substance is hydrophobic.

13. The reusable printing apparatus of claim 9 in which the coating of image forming substance is one of (a) a photosensitive material for forming an image by means of a photoprocess, (b) an erodible material formable into an image by means of an ablative process and (c) a photopolymer substance.

14. The reusable printing apparatus of claim 9 in which the material at the image support surface has a melting temperature range that is higher than at least one of (a) the decomposition temperature range and (b) the vaporization temperature range of the image forming substance.

15. The reusable printing apparatus of claim 14 in which the melting temperature range of the material at the image support surface is on the order of 500 centigrade degrees higher than at least one of (a) the decomposition temperature range and (b) the vaporization temperature range of the image forming substance.

16. The reusable printing apparatus of claim 9 in which the material of the image support surface has a melting temperature of not less than 1,000 centigrade degrees.

17. The reusable printing apparatus of claim 9 in which the material at the image support surface has a thermal conductivity range on the order of 10.0 - 240 watt/meter/degree K.

18. The reusable printing apparatus of claim 9 in which the body includes a substrate made of matter different than the material at the image to support the material at the image and having a thermal conductivity less than that of the material at the image.

19. The reusable printing apparatus of claim 18 in which the substrate is made of one of (a) aluminum oxide and (b) chromium oxide.

20. The reusable printing apparatus of claim 18 in which the material at the image support surface is coated on the substrate to a thickness on the order of 0.1 mils.

21. The reusable printing apparatus of claim 9 in which the substrate is a plate mountable to a plate cylinder of a printing press.

22. The reusable printing apparatus of claim 9 including an image forming substance heat facilitating catalyst mixed in with the material at the erasable image support surface.

23. The reusable printing apparatus of claim 22 in which the catalyst includes at least one of the metals Pt, Pd, Ir and Ni and the like or at least one of the oxides of Ce and Ru and the like for enhancing at least one of (a) oxidation and (b) volatilization of organic compounds.

24. A method of contact printing with a printing press, comprising the steps of:

forming a contact printable image on a printing member;

using the printing member to contact print a copy of the printable image; and

thermally erasing the contact printable image from the printing member while the printing member remains attached to the printing press to enable formation of a new contact printable image on the printing member.

25. The contact printing method of claim 24 including the step of forming a new contact printable image on the printing member while the printing member remains attached to the printing press after the one contact printable image is erased.

26. The contact printing method of claim 25 including the step of using the printing member to print a copy of the new contact printable image.

27. The contact printing method of claim 24 in which the step of forming a contact printable image on the printing member is performed while the printing member is attached to the printing press.

28. The contact printing method of claim 24 in which the step of forming the contact printable image is performed by a photographic imaging process.

29. The contact printing method of claim 24 in which the step of forming the contact printable image includes the steps of

preforming an erasable image support surface on the printing member,

applying a photoimagable substance as a thin film to the image support, and

selectively removing parts of the photoimagable substance from the image support surface to form the image.

30. The contact printing method of claim 29 in which the step of preforming an image support surface includes the steps of

preforming a hydrophilic support surface on the printing member, and

applying the photoimaging material as a thin film of hydrophobic photoimaging material to the image support surface.

31. The contact printing method of claim 29 in which the step of preforming the image support surface includes the step of coating the printing member with a material including at least one of (a) a ceramic material (b) a composite of ceramic and metal (c) a metal (d) a metal alloy and (e) other material with at least one of (1) a melting temperature range and (2) vaporization temperature range greater than that of the photoimagable substance.

32. The contact printing method of claim 29 in which

the photoimagable substance has (a) an oxidation onset temperature point (b) a decomposition onset temperature point and (c) a volatilization temperature point, and

removal is performed by raising the temperature of the photoimagable substance at least above one of said temperature points (a), (b) and (c).

33. The contact printing method of claim 24 in which the step of erasing is performed by the step of heating the contact printable image formed on the printing member.

34. The contact printing method of claim 33 in which the step of heating is performed by one of the steps of (a) combustion heating (b) microwave heating (c) laser heating (d) UV radiation heating (e) infrared radiation heating and (f) other radiant heating.

35. The method of claim 33 in which the step of heating is performed substantially simultaneously on the entire contact printable image.

36. A method of making a reusable contact printing apparatus, comprising the steps of:

forming a support body with a substrate surface adapted to support a reusable image support material; and

securing erasable image support material to the substrate surface to provide an image support surface for successive support of new coatings of image forming substance with preselected thermal characteristics and in which contact printing images are formable, said erasable image support material having thermal characteristics relative to the preselected thermal characteristics of the image forming substance to maintain structural integrity of the erasable image support material during application of sufficient heat energy to remove enough of the image forming substance from the image support surface to enable support of a new coating of image forming substance for formation of a new image.

37. The method of claim 36 in which said step of securing the erasable image support material to the substrate surface is performed by at least one of the steps of (a) spraying a coating of image support material onto the substrate surface, (b) thermal spraying the erasable image support material at temperatures near the melting point temperature of the image support material, (c) spraying the erasable image support material onto the substrate surface at speeds on the order of the speed of sound, and (d) spraying the image support material onto the substrate together with a high velocity oxygen fuel.

38. The method of claim 36 including the step of roughening the substrate surface to enhance adhesion of the image support material to the substrate surface.

39. The method of claim 36 in which said step of securing erasable image support material is performed by coating the substrate surface with the erasable image support material to a thickness on the order of 0.1 mils.

40. The method of claim 36 including the step of mixing a catalyst with the erasable image forming material facilitate removal of the image forming substance.

41. The method of claim 36 in which the erasable image support material is at least one of (a) ceramic (b) composite of ceramic and metal (c) metal (d) a metal alloy and (e) other material with at least one of (1) a melting temperature range and (2) vaporization temperature range greater than that of a substance from which the contact printable image is formed.

42. The method of claim 36 including the step of producing the erasable image support material at the support surface with a roughness on the order of fifty micro-inch Ra.

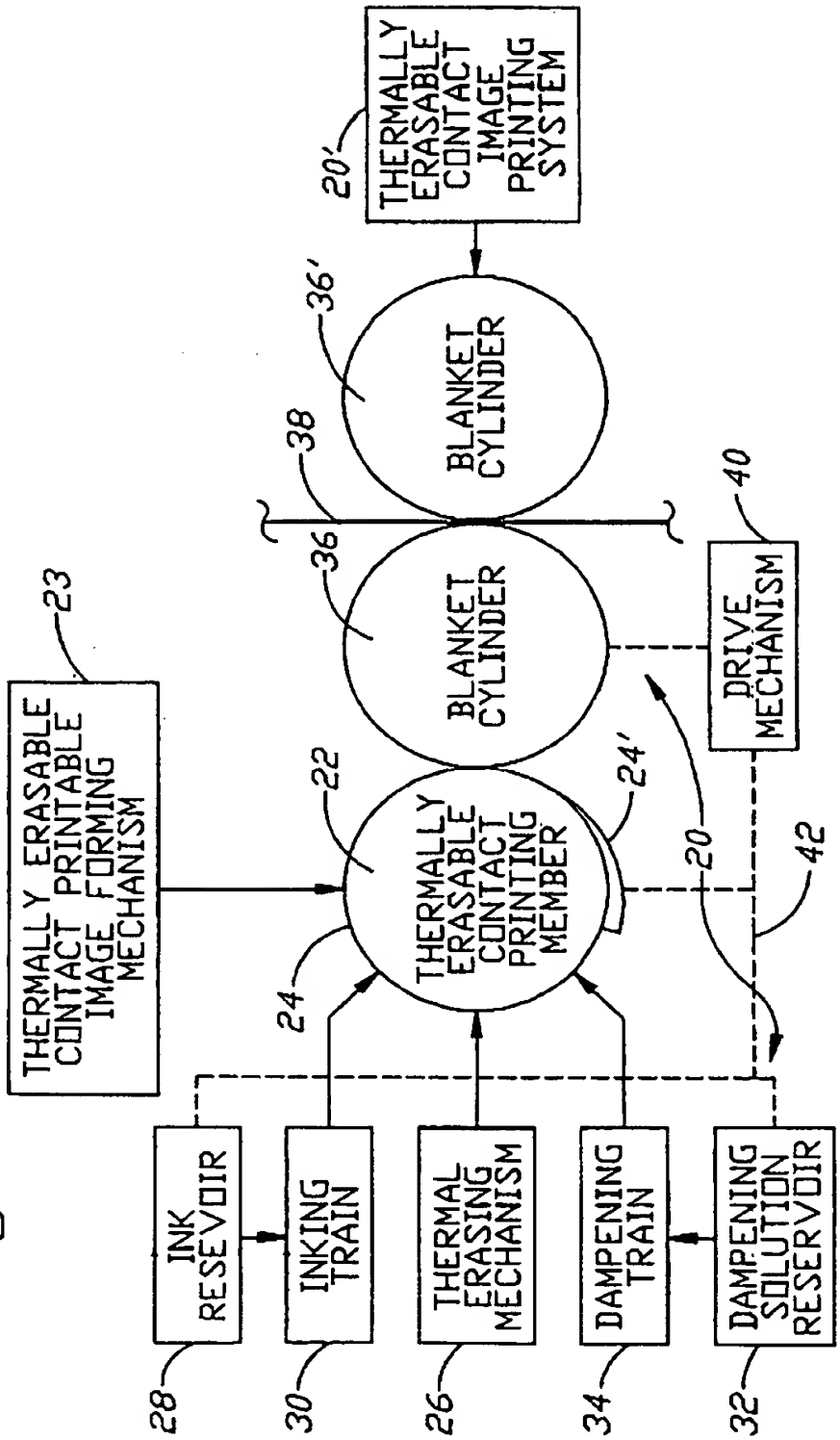
43. The method of claim 36 in which the erasable image support material has a melting temperature greater than one thousand centigrade degrees.

44. The method of claim 36 in which the step of forming a body is performed by forming the body with a substrate surface made of material different than the erasable image support material.

45. The method of claim 36 in which the body is made of a material having a thermal conductivity less than that of the image support material.

46. The method of claim 36 in which the substrate is made of one of (a) stainless steel and (b) carbon steel.

47. The method of claim 36 in which said step of forming includes the step of forming the support body with a cylindrical surface and said step of securing includes the step of securing the image support material in uniform conformity with the substrate surface to provide a cylindrical erasable image support surface.


THERMALLY ERASABLE CONTACT IMAGE PRINTING SYSTEM
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BLANKET CYLINDER
36'
38
40
BLANKET CYLINDER
36
DRIVE MECHANISM
THERMALLY ERASABLE CONTACT PRINTABLE IMAGE FORMING MECHANISM
23
22
24'
THERMALLY ERASABLE CONTACT PRINTING MEMBER
20
42
24
INK RESEVOIR
INKING TRAIN
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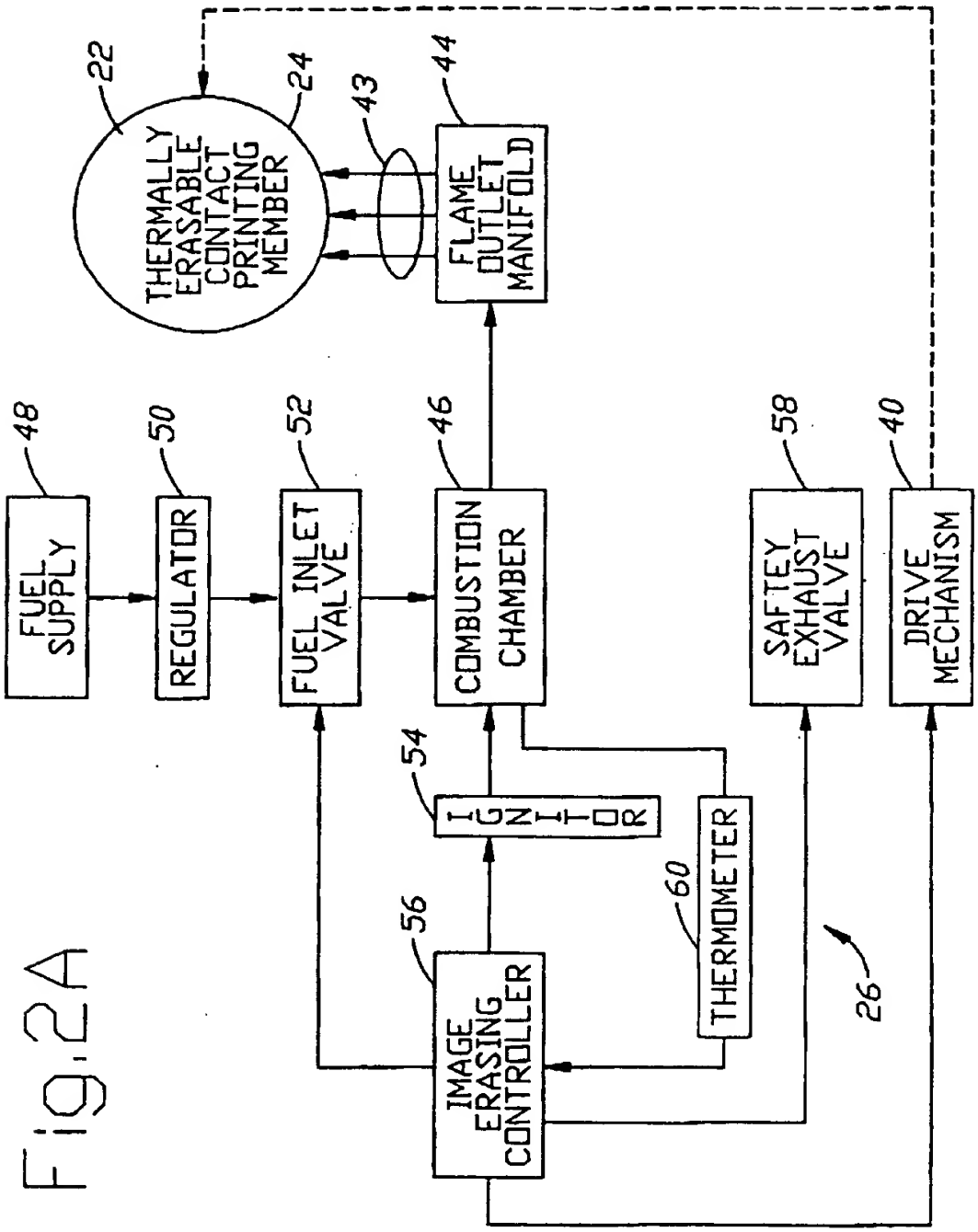
DAMPENING TRAIN
DAMPENING SOLUTION RESERVOIR
28
30
26
34
32

Fig.1


22
24
43
44
THERMALLY ERASABLE CONTACT PRINTING MEMBER
FLAME OUTLET MANIFOLD
48
50
52
46
58
40
FUEL SUPPLY
REGULATOR
FUEL INLET VALVE
COMBUSTION CHAMBER
SAFTEY EXHAUST VALVE
DRIVE MECHANISM
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IGNITOR
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THERMOMETER
56
IMAGE ERASING CONTROLLER
26

Fig.2A

Fig.2B

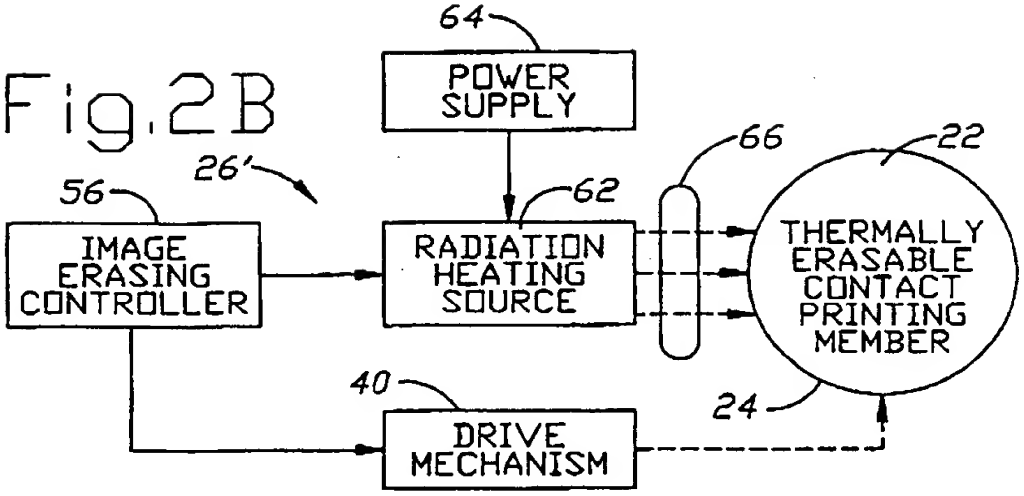

64
POWER SUPPLY
66
22
26'
56
62
IMAGE ERASING CONTROLLER
RADIATION HEATING SOURCE
THERMALLY ERASABLE CONTACT PRINTING MEMBER
40
24
DRIVE MECHANISM

Fig.3A

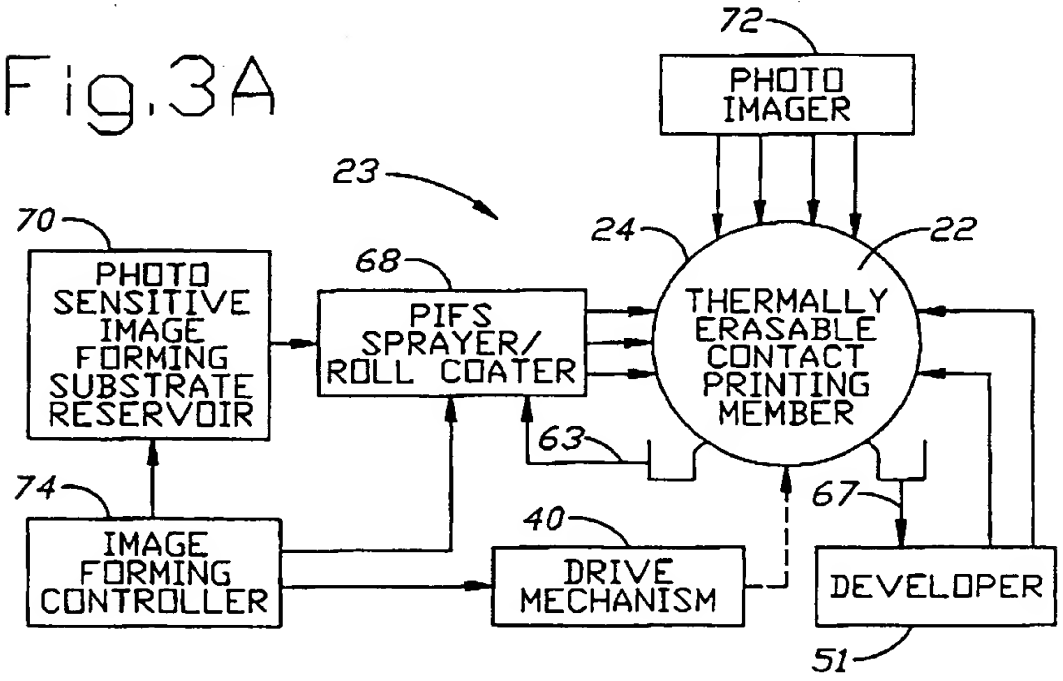

72
PHOTO IMAGER
23
70
24
22
68
PHOTO SENSITIVE IMAGE FORMING SUBSTRATE RESERVOIR
PIFS SPRAYER/ ROLL COATER
THERMALLY ERASABLE CONTACT PRINTING MEMBER
63
74
67
40
IMAGE FORMING CONTROLLER
DRIVE MECHANISM
DEVELOPER
51

Fig.3B

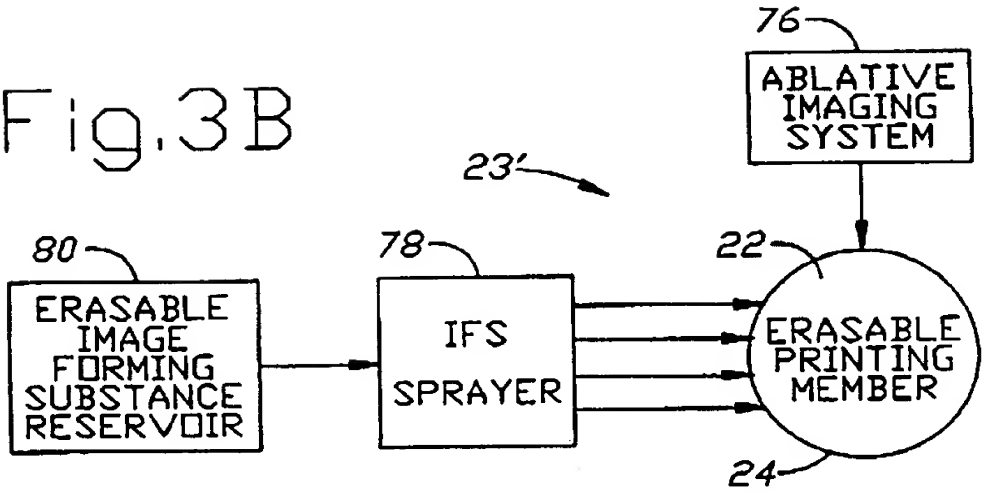


Fig.4A

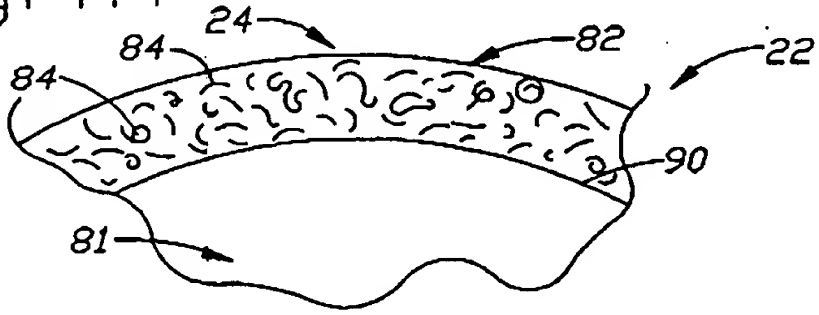


Fig.4B

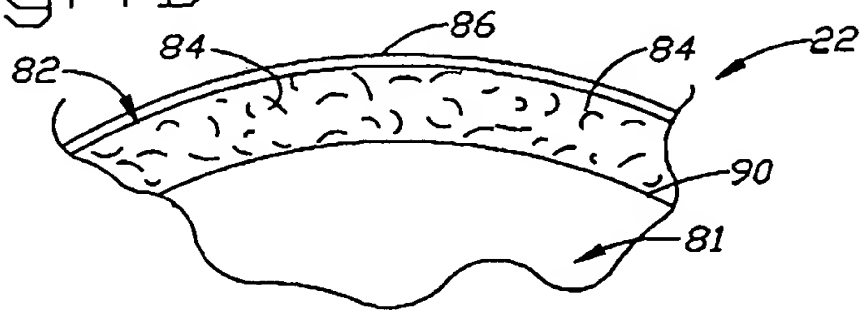


Fig.4C

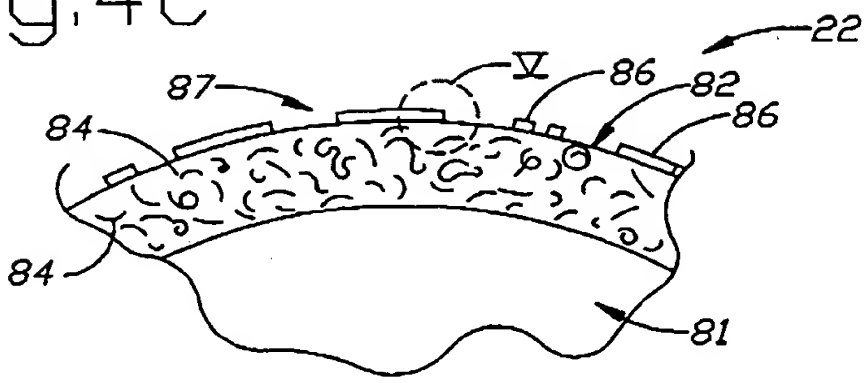


Fig.5

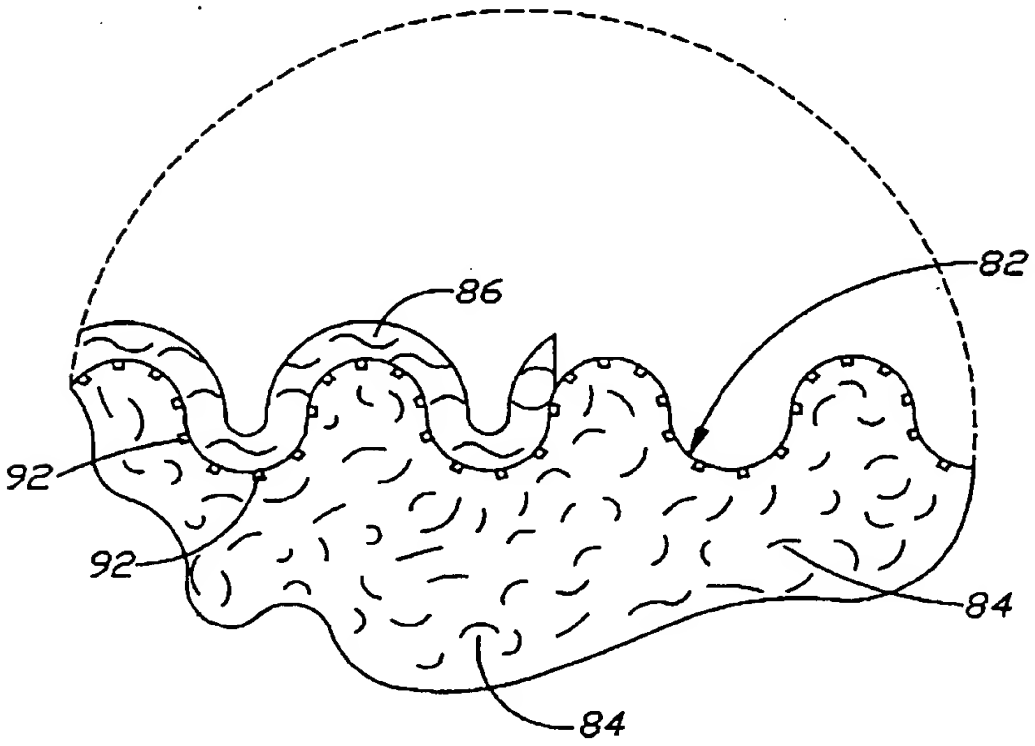


Fig.6

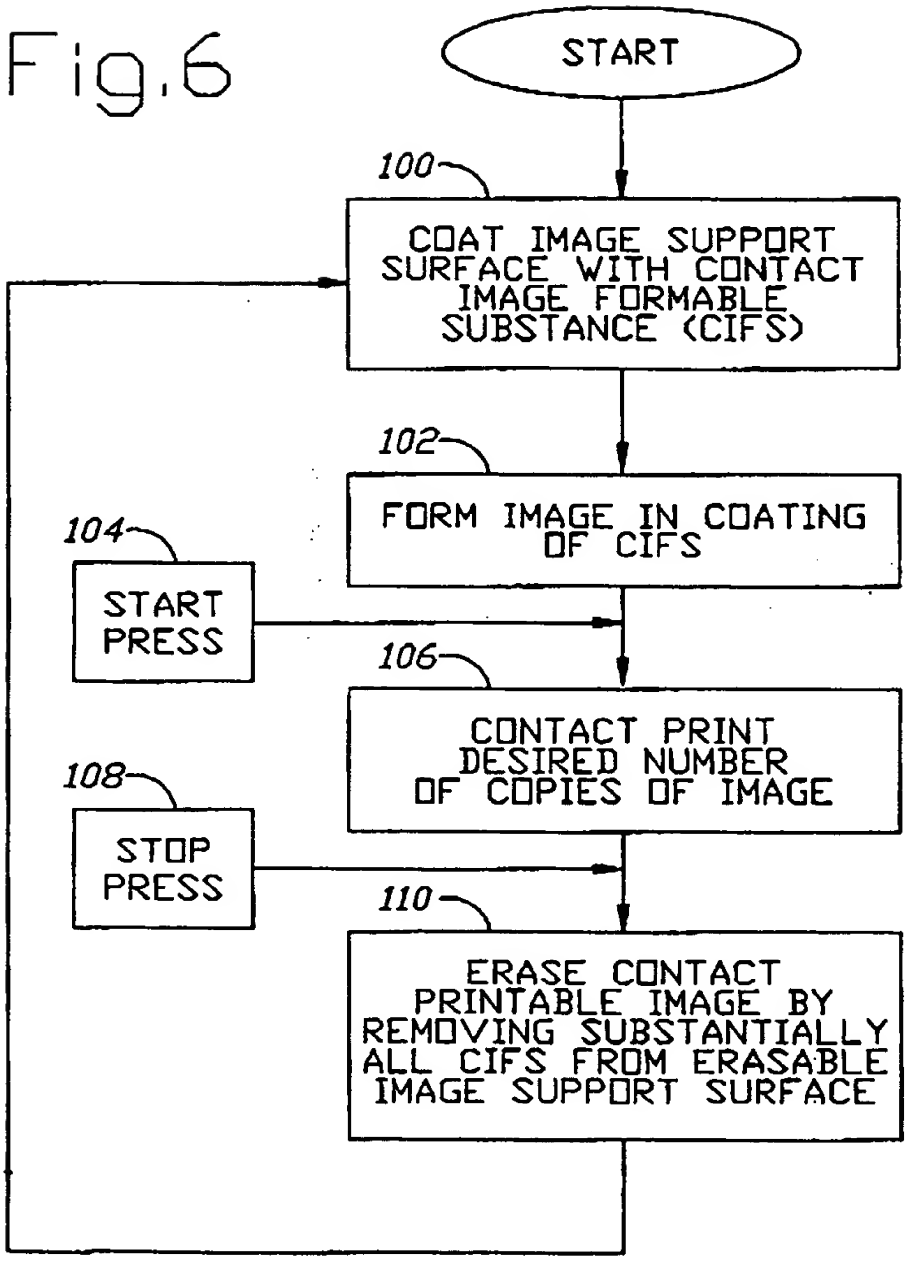
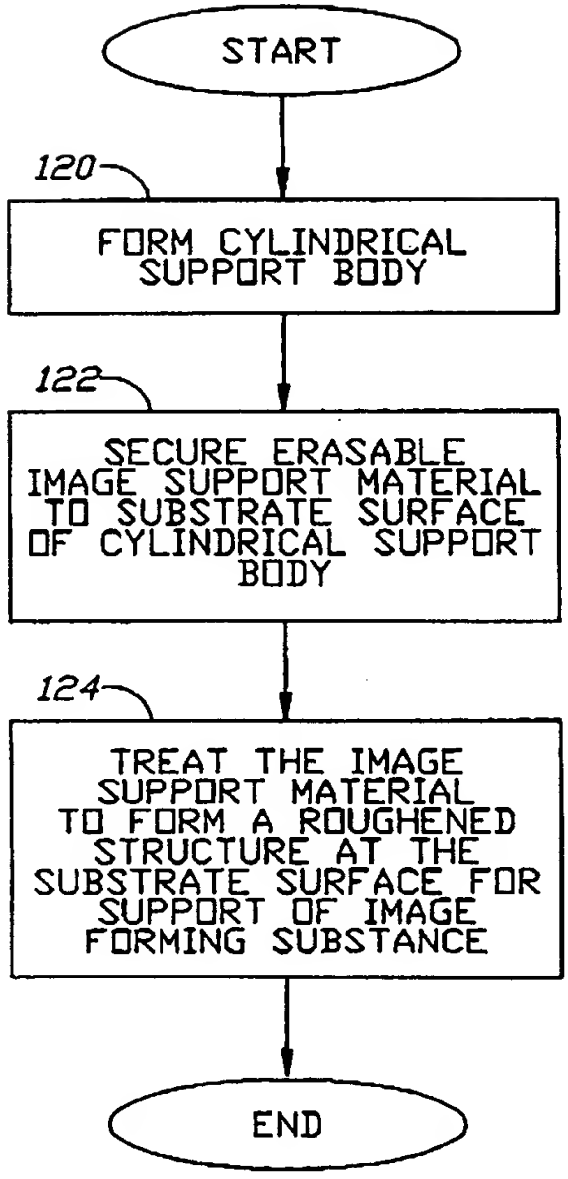

START
100
COAT IMAGE SUPPORT SURFACE WITH CONTACT IMAGE FORMABLE SUBSTANCE (CIFS)
102
FORM IMAGE IN COATING OF CIFS
104
START PRESS
106
CONTACT PRINT DESIRED NUMBER OF COPIES OF IMAGE
108
STOP PRESS
110
ERASE CONTACT PRINTABLE IMAGE BY REMOVING SUBSTANTIALLY ALL CIFS FROM ERASABLE IMAGE SUPPORT SURFACE

Fig.7


START
120
FORM CYLINDRICAL SUPPORT BODY
122
SECURE ERASABLE IMAGE SUPPORT MATERIAL TO SUBSTRATE SURFACE OF CYLINDRICAL SUPPORT BODY
124
TREAT THE IMAGE SUPPORT MATERIAL TO FORM A ROUGHENED STRUCTURE AT THE SUBSTRATE SURFACE FOR SUPPORT OF IMAGE FORMING SUBSTANCE
END

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 10 1264

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	PATENT ABSTRACTS OF JAPAN vol. 016, no. 464 (M-1316), 28 September 1992 & JP-A-04 164681 (RICOH CO LTD), 10 June 1992, * abstract *	1-5,9, 14, 24-29, 33,34,36	B41M5/36 B41M5/38 B41C1/10
Y		6,7,10, 12,13, 30,31, 41,46	
A	& JP-A-04 164 681	8	
Y	US-A-5 173 381 (NATANSOHN ALMERIA L ET AL) 22 December 1992 * column 2, line 59 - line 68 * * column 8, line 15 - line 38 * * abstract *	6,13	
Y	US-A-5 129 321 (FADNER THOMAS A) 14 July 1992 * column 3, line 34 - line 63 * * column 5, line 3 - column 6, line 25; figures 2-5 *	7,10,12, 30,31, 41,46	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B41M G11B B41C
D	& US-A-5 188 033		
A	PATENT ABSTRACTS OF JAPAN vol. 012, no. 341 (P-758), 13 September 1988 & JP-A-63 101844 (CANON INC), 6 May 1988, * abstract * & JP-A-63 101 844	1,9,24, 36	
A	US-A-5 213 041 (KANCK ASBJORN J) 25 May 1993 * the whole document *	1,9,24, 36	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	7 May 1996	Manntz, W

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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